LAPORAN PENYELIDIKAN

DEVELOPING WORKPLACE INJURY INDEX (WII) AS A MEASURE OF SAFETY AND HEALTH PERFORMANCE IN THE CONSTRUCTION INDUSTRY IN MALAYSIA

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ABSTRACT

The construction industry has been identified as one of the main catalysts for growth and accomplishment towards the country's aspiration to become a developed nation by 2020. However, the increasing trend of fatality in the construction industry has triggered a need for research to address the issue. Research has tended to focus on identifying the trends and types of injuries commonly observed in the construction industry. To date, however, no study to develop a specific measure of occupational safety and health performance in the construction industry especially in Malaysia has been carried out. It is unfortunate that, given the significance of OSH management at the workplace, serious academic attention has been neglected on such an important issue. As such, this study intends to fill in this important gap by attempting to develop an OSH performance measure that provide an indication of the safety and health level of employees in the workplace in the construction industry. This study identified three research objectives namely to identify common injuries in the construction sector, rank the common injuries in the construction sector based on severity of the injury and formulate a Workplace Injury Index as a measure of safety performance in the construction industry. A sample of 72 occupational health doctors registered with the Department of Occupational Safety and Health undertook the process of ranking 30 common injuries in the construction industry. The rankings were done using a scale of 1 (Not Severe) to 30 (Extremely Severe). The Thurstone's Discriminate Model was then used to develop an internal scale for severity of injury with 1= Not Severe and 30= Extremely Severe. The results of the severity ranking indicated the 5 least severe injuries were scratch, abrasion, bruise, blister, laceration and the 5 most extremely severe injuries are crushing of lower limb, deep burn

(< than 50%), electrical shock, deep burn (> than 50%) and asphyxia. Based on the result of the final ranking derived through the Thurstone's Discriminate Model, Workplace Injury Index (WII) was developed. The WII for the construction industry is WII = $1X_1$ (n) + $2X_2$ (n) + $3X_3$ (n) + …+ $30X_{30}$ (n), where X_1-X_{30} are the injuries ranked according to severity and n is the frequency of the respective injuries. This WII can now be used as a measure of determining safety performance in the construction industry.

TABLE OF CONTENT

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The construction industry is recognized as an important sector of any national economy, especially in relation to its employability potentials. However, the occurrence of workplace accidents, incidents, injuries and fatalities in construction sites around the world are regrettably high (Hinze, 1997). For example, the number of accidents and fatality rates in the Malaysian construction industry has made the industry one of the highly hazardous industries in the country. Table 1 below shows the number of fatalities resulting from workplace accidents from 2007 – 2011. These statistics have been obtained from the Social Security Organization (SOCSO), by industrial categories. Looking specifically at the construction industry, the fatality rates have been decreasing with the highest death rate recorded in the year 2007 (95 cases), making the construction industry the highest among the listed 9 industries. In comparison to the year 2007, the statistics for the year 2011 saw a significant drop in the reported fatality rate in the construction industry, which is approximately 46%. But in general, the reported fatality rate in the construction industry due to workplace accidents has been constant over the past years (2007-2011). Furthermore, the statistic reveals that the fatality rate in the construction industry contributes to an average of 35% of the total reported fatality rate due to workplace accidents.

Table 1.1

Number of Fatality by Industrial Categories (2007-2011)

Industrial Categories	2007	2008	2009	2010	2011
Agriculture, Forestry & Fishery	30	42	40	30	41
Mining & Quarry	9	6	2	1	0
Manufacturing	63	76	53	59	45
Electrical, Gas, Water & Cleaning	10	19	18	11	3
Construction	95	72	62	66	51
Trade	3	0	0	0	1
Transportation	2	8	8	14	11
Finance & Insurance Institution	4	4	1	1	6
Public Services	3	2	1	3	7

It should be noted that statistics obtained from the Social Security Organization (SOCSO) only cover those workers subscribing to SOCSO. However, according to the Master Plan for Occupational Safety and Health in Construction Industry 2005-2010, the actual figures may be much higher if those not subscribing to SOCSO are taken into account (www.cidb.gov.my). It is assumed that many workplace accidents among foreign workers in the industry are not reported to the authorities and hence the Social Security Organization (SOCSO) figures are only based on the accidents occurring among Malaysian workers only. In other words, these statistics only represent the reported cases only. In Malaysia, unreported cases may also be possible because this industry employs a large number of foreign workers who work as manual laborers either legally or illegally. The situation is made worse when the industry employs illegal foreign workers. As such, many workplace accidents go unreported for fearing legal implications faced by the employers.

Even though the fatality rate in the construction industry has shown a somewhat decreasing trend since 2007, the rate is still alarming to some extent since this industry, as mentioned earlier, contributes to 35% of the overall workplace accidents. The high fatality rate in the construction industry creates a negative image and hinders recruitment, especially among local people. In addition, the high rate of workplace accidents also has its implications to the organization's operating cost. For example, frequent accidents and property losses cause delays in operations and other indirect costs as well such as psychological trauma experienced by others at the workplace. An approach to overcome these negative implications for construction business success is to provide a safe and healthy workplace. Indeed, it has been shown that the construction industry has low awareness on the benefits of safety practices, which often results in higher production cost (Biggs, Dingsdag, Sheahan, & Stenson, 2005) and often safety will be the first item to face cost reduction.

Occupational safety and health is an important issue many employers in the construction industry seem unconcerned about to the prospect and success of the companies. Many researchers have found that high injury and fatality rates are primarily due to inadequate or non-existence of proper occupational safety and health management at workplace (e.g.

Bakri, Zin, Misnan & Mohammed, 2006). Therefore, the implementation of occupational safety and health management would lead to safer and healthier construction industry (Davies & Tomasin, 1996). The assumption here is that effective OSH performance will lead to fewer, if not zero, occupational injuries and fatality rates. Toward this end, various measures have been recommended by scholars and researchers alike. For example, Geller's (1997) safety triad is often been used by scholars to help managers on how to institute safe and healthy system of work in the organization.

Whilst it is important for managers to institute a safe and healthy work system, what seems to be taken as given is that occupational injuries and fatalities at work are something that could not be eradicated completely. Indeed, for various reasons and factors, this may be true. But to help managers better manage and control work procedures and systems so that they are safe, it is important that they know the level of safety and health performance at the workplace. Without such measure and understanding, efforts needed to circumvent occupational injuries and accidents at work may be fruitless as resources may not be properly channeled and not sufficiently allocated toward this end. So, it is the main intent of the present research to develop a measure of occupational safety and health performance for the construction industry so that it will aid identify the safety and health level in the construction industry, and hence outline relevant and appropriate action plans.

1.2 PROBLEM STATEMENT

It should be noted that OSH performance measures have been developed in other countries for a variety of industries such as manufacturing, public services, and etc. In the local front, however, few have attempted to develop a similar measure but for a different industry altogether (e.g. Ali, Abdullah & Subramaniam, 2005). To date, however, no study to develop a specific measure of occupational safety and health performance in the construction industry especially in Malaysia has been carried out. It is unfortunate that, given the significance of OSH management at the workplace, serious academic attention has been neglected on such measurement issue. As such, this study intends to fill in this important gap by attempting to develop a OSH performance measure that can give an indication of the safety and health level of employees in the workplace in the construction industry. Because of the said problems highlighted above, it is therefore necessary to develop an index that measures the level of occupational safety and health in the construction industry in Malaysia.

Furthermore, safety performance has been measured subjectively, based on self-report measures (e.g. Siu, Phillips, & Leung, 2004). Whilst subjective measures of safety performance are also able to provide indication of the level of safety and health of the organization, they are not free from biases and distortions. For example, one common question asked to the respondents was for them to indicate in the last five years or so the number of accidents or injuries they had experienced. Questions like these may lead to distortion because they involve memory work and hence guess work. It is also likely that self-reporting accidents may lead to under-reporting of accidents (Marottoli, Cooney, &

Tinetti, 1997). Furthermore, in order to save 'face' and appear they were safe and health conscious, the respondents may also conceal the truth by responding negatively to the question posed (Marottoli et al., 1997). Because of these potential limitations, the present study proposes that the measurement of OSH performance be developed using objective data i.e. actual injuries sustained at the workplace. Whilst objective data may also be open to debate, the degree of objectivity of the data is not necessarily compromised when proper documentation of the data is undertaken and in this case by the companies in the construction industry as well as interested third party agencies like SOCSO, DOSH, etc.

In addition, the need to study this issue in the construction industry is heightened and timely given the significance of the construction industry to the development of the country. The construction industry is an essential growth enabler because of its extensive multiplier effects on the rest of the economy, and its significance is heightened when the Ninth Malaysian Plan (9MP) places a heavy responsibility on this industry as one of the main catalysts for growth and accomplishment towards the country's aspiration to become a developed nation by 2020. Hence, to play its role effectively as envisioned, problems related to OSH issues have to be effectively addressed. Projecting a safe and healthy image, this industry will be much more attractive especially for local people to join, and hence issues of overreliance on foreign workers can be partially resolved.

1.3 OBJECTIVES OF RESEARCH

The specific objectives of the research are as follows:

a. To determine common workplace injuries in the construction industry.
b. To develop a severity ranking of the common injuries in the construction industry.
c. To develop a weighted workplace injury in the construction industry called the Workplace Injury Index (WII) as a measure of occupational safety and health performance in the construction industry.

1.4 SIGNIFICANCE OF THE STUDY

This study looks into aspects of developing a Workplace Injury Index to act as a measure of workplace safety performance. The findings from this study may benefit both theory and practice. This study is important as it contributes to the body of knowledge by identifying the common injuries in the construction sector. In addition, this study further contributes to knowledge by assigning weightage to the selected injuries based on expert ranking by Occupational Health Doctors registered with DOSH. Previous studies measured safety performance from a subjective perspective and very limited studies attempted to use an objective measure. This study will be among the very first few studies that measured safety performance from an objective stand point in the construction industry.

In addition, the study intends to contribute to the literature concerning safety performance by: (a) identifying common injuries in the construction sector; (b) ranking the common injuries in the construction sector based on severity of the injury; and (c) formulating a Workplace Injury Index as a measure of safety performance in the construction industry.

The study also intends to heighten the knowledge of occupational safety professionals and relevant agencies that deals with occupational safety and health matters mainly the Department of Occupational Safety and Health (DOSH), Social Security Organization (SOCSO), National Institute of Occupational Safety and Health (NIOSH) specifically as they relate to occupational safety performance. The findings of this study will provide empirical evidence as to the injuries in the construction sector with the severity factor weighted in. In turn this would give a meaningful representation of the frequency of workplace injuries in the construction sector reported in the country. In addition relevant regulating agencies could use WII to compare the standards of occupational safety between companies in the construction industry.

CHAPTER 2

LITERATURE REVIEW

2.1 IMPERIAL STUDIES ON WORK PLACE INJURIES

Ali, Abdullah and Subramaniam (2009) in examining management practices in safety culture posited that while implementing good management practices does reduce injury rates however the relationship between different management practices and injury rates do not provide a true account of the severity of these injuries. In their observation of injury rate of 68 Malaysian companies over three years from 2001 to 2003, the severity of 24 musculoskeletal injuries was investigated in correlation with six managerial practices i.e. hiring practices, management commitment, employee participation, reward, training, communication and feedback. Their result obtained from multiple regression analysis indicated that while a significant linear relationship between management practices subscale and injury rate is obtained nevertheless, the coefficient correlation indicated that only management commitment and feedback as well as employee participation were significantly related to injury rates where management commitment by (t= -1.96) come close to significant . Other managerial practice subscales were found to be not significant.

Similar findings observed by Dodge (2012) in an inquiry of root causes of serious workplace injury. Dodge (2012) inductively identified lack of commitment to safety within the organization and lack of positive safety leadership by management as precursors of injury. This study is based on grounded theory method of investigation and data produced through document received from Nova Scotia Department of Labour and Workforce Development, Occupational Health and Safety Division and supplemented by interviews of purposefully selected experts. The paper reports number of themes of root causes of injury used systems-based safety management as a theoretical lens. The findings of the study indicate that culture in safety and health matters were strongly embedded in managerial decision making.

Bakhtiyari et al. (2012) in an epidemiological study of pattern of occupational accidents among workers and drivers who had a work-related accident during 2001–2005. The study assessed 86,437 work-related accidents during that period. Subjects were analyzed through ordinal logistic regression model (proportional odds regression model) and the study reported more frequent accident in metal workplaces and electrical industries where more than half of the accidents were due to incautious activities. Root of work place accident in this study was embedded in bleak devices, defective equipment, carelessness, improper light, poor ventilation, dangerous clothes, lack of information and other causes. The distribution of accident type shows that the most common type of accidents were related to slip and fall (18.5%), concussion and members sprain (12.76%), lacerations and amputations (11.1%) and broken organs (10.46%). In a regression analysis, accident (event) was considered as dependent variable (response), and gender, marital status, age, accident setting, accident cause and type of activity in injured victim were considered as independent variables. The findings indicate meaningful effect of age on response variable as such by increasing age, the risk of accident was decreased, and also chances of women exposure to injury in different classes is 1.3 times higher compared to men.

Barss, Addley, Grivna, Stanculescu, and Abu-Zidan (2009) developed occupational injury patterns within foreign construction, farm and industrial workers in the United Arab Emirates. Prevention-related variables over three years 2003 to 2005 were analyzed using SPSS and severity was quantified by injury severity scores (ISS). ISS was calculated as a single aggregate score for all bodily injuries derived manually using the Anatomical Injury Score (AIS). The epidemiologic study of this research developed based on Machinery/power tools (Saw , Grinder , Cutter , Unknown) , Animal-related (Hits/kicks , Falls , Bites , Unknown) , Burns (Fire , Oil , Electrical , Hot water , Unknown) , Other injuries (Road traffic , Assault , Unknown). Severities of injury assessed by ISS showed clear extremities in occupational injuries, effective countermeasures were needed to reduce the incidence and severity of occupational injury. The study concluded that the most important implementation lies in the fact that improved data collection on occupational injury is needed, together with access to occupational health services and rigorously enforced adherence to good health and safety practice.

In 2009 Leiter, Zanaletti, and Argentero demonstrated the occupational risk perception in a printing industry through investigating 350 workers from 6 departments in the Italian printing industries. A structural equation analysis in this study confirmed a model of risk perception on the basis of employees' evaluation of the prevalence and lethalness of hazards as well as the control over hazards they gain from training. The results of this study indicate the importance of training interventions in increasing workers' adoption of safety procedures and prevention of injuries. This research has thrown up many questions in need of further investigation about safety procedures reflect an ideal type of safety policy correlated with the alternative injury.

Schwatka, Butler, and Rosecrance, (2012) point out that understanding health and safety is critical, especially in the construction industry, where physical job are heavily involve. According to them the epidemiologic literature on the impact of age on injury among workers demonstrated that age and injury was related to higher injury costs but not to number of injuries. Relative causes of injuries in the construction industry demonstrated falls as the major concern for the construction industry. The finding of this study indicate that musculoskeletal disorders are particular types of injuries because of the precarious and physically challenging nature of work conditions in the construction industry. The study concluded that further investigation should be done to investigate the injury type and severity of this occupation risk in construction sectors because of its effect on overall productivity.

Bahn (2013) in an investigation of 77 employees of an underground mining operation in Western Australia aimed to identify any strategies to control the list of emerging hazards. The identification of hazard in this study was based on three factors of obvious, emerging as well as hidden hazards. The most commonly identified obvious hazards include: moving machinery (72%), unsupported ground (55%), faulty equipment (50%), misfires/explosives (50%), slips and trips (38%), and incorrect personal protective equipment (PPE) (38%). These findings further identified 22 trivial hazards including: poor housekeeping (55%), faulty equipment (44%), slips and trips (38%) and spillage (33%). This study produced 23 emerging hazards including: 72% identifying faulty machinery, and 55% noting fatigue/boredom rushing hazards. The final category was the hidden hazards were 24 groups identified including gas leaks, hydraulic pressure, electrical faults, water hazards underground and human behavior and a lack of knowledge as hidden hazards while uncontrolled ground movements, unsupported ground and weather conditions also noted as hidden hazards. They suggested that there is a need to provide further risk management in hazard identification and controlling.

The study of Amirahm, Asma, Muda, and Amin, (2013) shows the importance of occupational safety and health in reducing risk at the workplace. This study by highlighting the high accident rate in manufacturing industries in Malaysia concludes that lack of safety culture and non-compliance inadvertently led to workplace hazard. This finding corroborates the ideas of Ali, Abdullah and Subramaniam (2009) who suggested that reduction of accidents rate in an organizational behavior and compliance to safety management system will lead to positive safety performance. Similarly Amirahm et al. (2013) found that right combination of rules, believes, attitudes and good practice is required to mitigate occupational risk. However, their research shows the possibility of challenges to the government and policy makers despite well-developed laws and regulations. As such the question remains to what extent laws are properly enforced and complied by the industries and how positive attitude and perception can be developed among decision makers.

Cheng, Leu, Cheng, Wu and Lin (2011) through data mining method known as classification and regression tree (CART) investigated the causes and distribution of occupational accidents regarding serious occupational accidents in the Taiwan construction industry. The results of this study show that apart from the inherently dangerous nature of construction work, occurrence rules for falls and collapses serve as key factors to predict the occurrence of occupational injuries. This study in an attempt to identify the cause-and-effect relationships of work place injury, investigated 1542 reports of accidents and fatalities in construction industries in Taiwan. The study found fall/tumble was found the most common cause of injury among all accident types. According to the results of the study there are many factors that contribute to injuries sustained in such an environment therefore proper measure of all kinds are required to prevent or minimize occupational injuries.

Aminbakhsh, Gunduz, and Sonmez (2013) by using analytic hierarchy process method evaluated the occupational risk during planning and budgeting of construction projects. Construction projects were characterized as having among the highest injury and death rates compared to other industries. This study produced results of a hierarchy of accident hazard, physical hazard and chemical hazard affecting construction safety. Accident hazards were break down into three sub parts i.e. trips & falls, electricity & lighting and fire & explosions. Physical hazard are related to machinery & equipment, vibration and temperature. Similarly chemical hazards are ventilation, burns and neurological type of injury. This finding supports previous research which suggested that adequate prioritization of safety risks is crucial for planning occupational safety related risks. The study suggested the need to develop an adequate decision tool for the decision makers for accident/injury prevention strategy.

Arquillos, Romero and Gibb (2012) in their causes root study of construction accidents in Spain evaluated 10 variables and evaluated each of these variables with respect to the severity of the accident. These variables were categorized in 5 group of Personal (Age), Business (National Classification of Economic Activities, Company Staff, Length service, Location of Accident), Temporal (Day of the week, Days of absence) , Material (Deviation, Injury) and Geographic (Climatic Zones). Aimed obtaining a new extended and identifies suitable mitigating actions this study analyzed total of 1,163,178 accidents between 2003 and 2008 with respect to the cause relation and severity of the accident. One of the more significant findings emerge from this study was identified indifference accidents rate in large or small companies in the aspect of fatal accidents, further this study shows accidents occurring away from the usual workplace. However it concluded more accurate approach to updated insight to the likely causes of construction accidents is required.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will explain and discuss the methodological approach used in this research. First it will explain the development of the injury list used in this research. Second the selection of the sample of the physicians who will undertake the ranking of the severity of the injuries will be explained. Finally this chapter will discuss the Thurstone Discriminate Model technique used to obtain the final severity rankings of the injuries sustained in the construction industry.

3.2 INJURY LIST

The first stage of the study involved the identification of injuries sustained by employees in the construction sector. In the first stage a comprehensive list of injuries was drawn up based on the PERKESO Annual Report. A list of more than 50 injuries was obtained from the PERKESO report.

In the second stage the study examined the International Labour Organization Report III Statistics of Occupational Injuries. This report was presented by ILO at the Sixteenth International Conference of Labour Statisticians in Geneva from 6 – 15 October 1998. The type of injuries listed in Annexe E (see Appendix 1) of the Report was compared with the PERKESO Report. A list of injuries based on these 2 reports was then drawn up. This list contains 52 injuries.

In the third stage this study wanted to identify common injuries sustained in the construction industry. In order to do these the researchers identified three experts in Occupational Safety and Health to assist in drawing up the list of common injuries sustained in the construction sector. The first expert is a senior officer in the Department of Occupational Safety and Health (DOSH) Kedah office handling accidents investigations. The second expert is a senior officer attached to the Putrajaya DOSH office responsible for policy and research. Finally the third expert is a senior officer from PERKESO head office in Kuala Lumpur responsible also for policy and research. The researcher presented the list of 52 injuries derived from the ILO and PERKESO reports to these experts and asked them to identify the most common injuries sustained in the construction industry. After several rounds of discussions with these 3 experts the original list of 52 injuries was whittled down to 30 common injuries. The final list of these 30 common injuries is shown in Table 4.1.

3.3 RANKING THE INJURIES

A ranking was carried out to determine the severity of the 30 injuries. The severity of the injuries were ranked based on the scale of 1 (not severe) to 30 (extremely severe) (Vredenberg, 2002). The ranking of the injuries was done by experts who are physicians specializing in occupational health.

3.4 SAMPLING FRAME

A list of all the doctors specialising in occupational health was obtained from DOSH. This list contains all the doctors who are registered with DOSH who are qualified as occupational health doctors. Based on the DOSH 2012 Register there were 458 doctors registered as occupational health doctors. Table 3.1 shows the breakdown according to the states in Malaysia.

Table 3.1

Occupational Health Doctors Registered with DOSH in 2012

State	Number
Johor	38
Kedah/Perlis	15
Kelantan	13
Melaka	20
Negeri Sembilan	18
Pahang	22
Kuala Lumpur	48
Perak	23
Pulau Pinang	40
Sabah	48
Sarawak	36
Selangor	110
Trengganu	27
Total	458

According to Krejcie & Morgan (1970) for a population size of 458 elements the minimum number of sample required is 210 respondents. However to ensure that this study obtain a good response rate the total number of respondents included in this study was 350 occupational health doctors. This comprised an additional 66% of respondents above the minimum 210 respondents.

The sampling technique used in this study was simple random sampling. In the original list given by DOSH, the listing of occupational health doctors was according to the states in which they were practicing. However for the purpose of random sampling all the 458 occupational health doctors were listed in a single list (master list) by name and were numbered from 1 to 458. Following this the number 1 to 458 was written on small pieces of paper, folded and placed into a box. Subsequently 350 ballots were drawn from the box and the numbers were matched against the master list to determine the sample selected. Based on the names and addresses of these 350 respondents a questionnaire requesting the occupational health doctors to undertake a ranking of the severity of the 30 common injuries in the construction industry were sent out to them.

3.5 QUESTIONNAIRE

A one page questionnaire that has a listing of the 30 common injuries sustained in the construction industry was developed for the ranking purpose (see Appendix 2). The injuries were listed in no particular order. The instruction to the respondents require them to rank these 30 injuries from 1 (Not Severe) to 30 (Extremely Severe). The respondents were told that when making their ranking to take into consideration the extent to which the injury may affect factors such as days off from work, permanent or long-term inability to perform job duties, medical expenses, as well as whether the injury is life threatening The questionnaires were mailed to the 350 respondents. Included in the questionnaire pack is a self-addressed postage paid envelope to be used by the respondents to return the completed questionnaire that contains the rankings. A total of 104 questionnaires were returned. However 32 questionnaires were unusable because they had incomplete rankings. Therefore only 72 questionnaires with complete rankings were usable for the analysis giving a response rate of 20.6%.

Based on the rankings data provided by the 12 physicians, these rankings were converted into an interval scale using Thurstone's Discriminate Model (McIver & Carmines, 1981). Table 3.1 provides the severity of the injuries from 1 (not severe) to 24 (extremely severe). The rankings obtained in Table 3.1 are then used for weighting in subsequent analysis.

3.6 ANALYSIS

The rankings obtained from the 72 occupational health doctors were analysed using the Thurstone's Discriminate Model (McIver & Carmines, 1981). According to the TDM the rankings given by the respondents in the survey questionnaire will be converted to an interval scale ranging from 1 (Not Severe) to 30 (extremely severe). To undertake this ranking for each injury by the 72 respondents were input into Excel spread sheet. The final spread sheet will comprise of a 72 X 30 matrix. Once this is completed the frequency counts of the severity of each injury is computed. For instance to determine the least severe injury the injury that has the most ratings of 1 is computed. The study found that the highest frequencies of 1 i.e. 37 was obtained for Scratch. As such Scratch emerged as the least severe injury. Likewise to determine the most severe injury, the highest frequencies for 30 are counted. The analysis found that Asphyxia had the highest count of 19 compared to the other injuries. Thus Asphyxia was determined to be the most severe injury. The same process was repeated for all the other injuries in descending order from 1 to 30.

CHAPTER 4

FINDINGS

4.1 INTRODUCTION

This chapter presents the findings of the study. The chapter comprises of three sections. Section 4.1 presents the common occupational injuries observed in the construction industry. Section 4.2 presents the severity ranking of the common injuries in the construction industry. Finally, Section 4.3 presents weighted occupational injuries as a measure of occupational safety and health performance in the construction industry.

4.2 COMMON INJURIES

Table 4.1 depicted the thirty most common occupational injuries observed in the construction industry. The type of injuries can be grouped into eight categories namely fracture of limb, amputation of limb, crushing of limb, poisoning, burn, electrical hazard, biological, and physical injuries.

Table 4.1

Common occupational injuries

Injury	Type
Fracture of upper limb	Fracture
Fracture of lower limb	
Amputation of upper limb	Amputation
Amputation of lower limb	
Crushing of upper limb	Crushing
Crushing of lower limb	
Poisoning through splash	Poisoning
Poisoning through ingestion	
Poisoning through inhalation	
Poisoning through bites by venomous animal	
Superficial Burn (less than 50%)	Burn
Superficial Burn (more than 50%)	
Deep Burn (less than 50%)	
Deep Burn (more than 50%)	
Electrocution	Electrical
Electrical shock	
Bites of non-venomous insects	Biological
Scratch	Physical
Abrasion	
Bruise	
Blister	
Laceration	
Strains	
Sprains	
Contusion	
Dislocations	
Concussions	
Radiation	
Injury to Eye	
Asphyxia	

4.3 SEVERITY RANKING

Table 4.2 depicted the severity ranking of common injuries from 1 (Not Severe) to 30 (Extremely Severe). Seven types of injuries caused by physical hazard (i.e. scratch, abrasion, bruise, blister, laceration, strains, and sprains) were ranked least severe injuries observed in the construction industry. The top five extremely severe injuries in order are asphyxia, deep burn (more than 50%), electrical shock, deep burn (less than 50%) and crushing of lower limb.

Table 4.2

Severity ranking

Severity	Injury	Type
1.	Scratch	Physical
2.	Abrasion	
3.	Bruise	
4.	Blister	
5.	Laceration	
6.	Strains	
7.	Sprains	
8.	Bites of non-venomous insects	Biological
9.	Contusion	Physical
10.	Dislocations	
11.	Concussions	
12.	Fracture of Upper Limb	Fracture
13.	Poisoning through splash	Poisoning
14.	Poisoning through ingestion	
15.	Poisoning through inhalation	
16.	Radiation	Physical
17.	Fracture of Lower Limb	Fracture
18.	Superficial Burn (less than 50%)	Burn
19.	Poisoning through bites by venomous animal	Poisoning
20.	Injury to Eye	Physical
21.	Superficial Burn (more than 50%)	Burn
22.	Electrocution	Electrical
23.	Amputation of Lower Limb	Amputation
24.	Amputation of Upper Limb	
25.	Crushing of Upper Limb	Crushing
26.	Crushing of Lower Limb	
27.	Deep Burn (less than 50%)	Burn
28.	Electrical Shock	Electrical
29.	Deep Burn (more than 50%)	Burn
30.	Asphyxia	Physical

4.4 WEIGHTED OCCUPATIONAL INJURIES

Based on severity ranking, an index was developed by weighting the frequency of injury with its severity. This would enable the computation of a uniform score of workplace safety performance in the construction sector. This would also serve as a measure to calculate safety performance score.

WII is calculated as per the equation below, where X_1-X_{30} denotes the common injuries in construction sector, from not severe to extremely severe. The numerical value of 1-30 represents the severity of injuries as ranked by experts.

$$\mathbf{WII = 1X_1\,(n) + 2X_2\,(n) + 3X_3\,(n) \ldots 30X_{30}\,(n)}$$

WII: Workplace Injury Index

X_1-X_{30}: type of injuries in the order of severity from 1 (not severe) to 30 (extremely severe)

n: frequency of injuries sustained for each type of injury

X_1: scratch; X_2: abrasion; X_3: bruise; X_4: blister; X_5: laceration; X_6: strains; X_7: sprains; X_8: bites of non-venomous insects; X_9: contusion; X_{10}: dislocations; X_{11}: concussions; X_{12}: fracture of upper limb; X_{13}: poisoning through splash; X_{14}: poisoning through ingestion; X_{15}: poisoning through inhalation; X_{16}: radiation; X_{17}: fracture of lower limb; X_{18}: superficial burn (less than 50%); X_{19}: poisoning through bites by venomous animal; X_{20}: injury to eye; X_{21}: superficial burn (more than 50%); X_{22}: electrocution; X_{23}: amputation of lower limb; X_{24}: amputation of upper limb; X_{25}: crushing of upper limb; X_{26}: crushing of lower limb; X_{27}: deep burn (less than 50%); X_{28}: electrical shock; X_{29}: deep burn (more than 50%); X_{30}: asphyxia

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

The purpose of this study is to develop a workplace injury index. The workplace injury index is established because the current practice of reporting workplace injury relies on the frequency of occurrences without incorporating the severity of the respective injury. These frequencies do not give a meaningful representation of the actual safety performance in the construction sector. Having a workplace injury index would facilitate Safety and Health Officers to develop mitigation strategies in order to provide a safe work environment. The results presented in the preceding chapter are discussed in the following section.

5.2 DISCUSSION

The study obtained the list of the injuries from the International Labor Organization (ILO) which was an extensive list comprising 52. This list of injuries was then compared with the list provided by the Department of Occupational Safety and Health (DOSH), Malaysia and the Social Security Organization (SOCSO), Malaysia. The validation process began with series of discussion with senior officers from both the departments. As a result 30 common occurring injuries in the construction industry were identified.

These injuries comprised of fractures, amputation, crushing, poisoning, burn, electrical, biological, and physical in nature.

However, no attempts to incorporate severity of injury has been attempted thus far to develop a performance index of safety at the workplace in the construction industry. This study has attempted to do that by including severity of injury to give a meaningful representation of the actual workplace safety scenario in the construction industry. This was done through a rigorous scientific approach whereby the severity of the injury was ranked by Occupational Health Doctors (OHD) who has vast experience dealing with workplace injury. The injuries were ranked from 1 representing Not Severe injury to 30 representing Extremely Severe injury. The examples of injuries that are included e.g. bruise, abrasion and scratch while extremely severe injuries included crushing of lower limb, deep burn and asphyxia.

This study has developed an index called Workplace Injury Index (WII) which can be a meaningful indicator of safety performance for the construction industry. The WII is determined by multiplying the frequency of occurrence of the 30 common injuries with the severity ranking of each type of the injuries. The WII will then provide a strong indicator of the level of safety performance of companies in the construction sector.

It is recommended that the future research attempts should obtain data from the construction companies and use the WII to establish a general norm of safety performance of construction industry in Malaysia. Besides that Safety and Health Officer

(SHO) could use this index as a mandatory reporting of safety and health related matters to the relevant agencies. Construction companies could also use this index to project a safe and healthy image, which in turn would attract especially local citizens to work in this industry. Hence issues of overreliance on foreign workers could be partially resolved. This approach could also be adapted to other industries so that a comprehensive index comprising of all major sectors of the economy could be developed to assist Department of Occupational Safety and Health (DOSH) and Social Security Organization (SOCSO) develop an Occupational Safety and Health (OSH) master plan for the nation.

REFERENCE

Ali, H., Abdullah, N. A. C., & Subramaniam, C. (2009). Management practice in safety culture and its influence on workplace injury: an industrial study in Malaysia. *Disaster Prevention and Management,* 18(5), 470-477.

Aminbakhsh, S., Gunduz, M., & Sonmez, R. (2013). Safety risk assessment using analytic hierarchy process (AHP) during planning and budgeting of construction projects. *Journal of Safety Research,* 46, 99-105.

Amirah, N. A., Asma, W. I., Muda, M. S., & Amin, W. A. A. W. M. (2013). Safety Culture in Combating Occupational Safety and Health Problems in the Malaysian Manufacturing Sectors. *Asian Social Science*, 9(3), p182.

Bahn, S. (2013). Workplace hazard identification and management: The case of an underground mining operation. *Safety Science*, 57, 129-137.

Bakhtiyari, M., Delpisheh, A., Riahi, S. M., Latifi, A., Zayeri, F., Salehi, M., & Soori, H. (2012). Epidemiology of occupational accidents among Iranian insured workers. *Safety Science*, 50(7), 1480-1484.

Bakri, A., Zin, R. M., Misnan M. S., and Mohammed,A. H. (2006) Occupational Safety and Health (Osh) Management Systems: Towards Development Of Safety and

Health Culture, Proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006) pp. C19-C28.

Barss, P., Addley, K., Grivna, M., Stanculescu, C., & Abu-Zidan, F. (2009). Occupational injury in the United Arab Emirates: epidemiology and prevention. *Occupational medicine*, 59(7), 493-498.

Biggs, H. C., Dingsdag, D.P., Sheahan, V.L., and Stenson, N.J. (2005) The Role of Collaboration in Defining and Maintaining a Safety Culture: Australian Perspectives in the Construction Sector', Farzad Khosrowshahi (ed), Association Of Researchers in Construction Management, Proceedings, 21st Annual ARCOM Conference, SOAS, London.

Cheng, C. W., Leu, S. S., Cheng, Y. M., Wu, T. C., & Lin, C. C. (2011). Applying data mining techniques to explore factors contributing to occupational injuries in Taiwan's construction industry. *Accident Analysis & Prevention*, 48, 214-222.

Dodge, R. B. (2012). Patterns of root cause in workplace injury. *International Journal of Workplace Health Management*, 5(1), 31-43.

Geller, E. S. (1997).Key processes for continuous safety improvement: Behavior-based recognition and celebration. *Professional Safety*, 42 (10), 40-44.

Hinze, Jimmie W., (1997), "Construction Safety." Prentice-Hall, Inc., Upper Saddle River, NJ.

Leiter, M. P., Zanaletti, W., & Argentero, P. (2009). Occupational risk perception, safety training, and injury prevention: Testing a model in the Italian printing industry. *Journal of occupational health psychology*, 14(1), 1-10.

López Arquillos, A., Rubio Romero, J. C., & Gibb, A. (2012). Analysis of construction accidents in Spain, 2003-2008. *Journal of safety research*, 43, 381-388.

Marottoli, R. A., Cooney Jr., L. M., & Tinetti, M. E. (1997). Self-report versus state records for identifying crashes among older drivers. Journal of Gerontology. Series A, Biological Sciences and Medical Sciences, 52, 184– 187.

Mclever, J.p., & Carmines ,. (1981) . unidimensional scalling. Beverly Hills, Sage Publications.

Schwatka, N. V., Butler, L. M., & Rosecrance, J. R. (2012). An aging workforce and injury in the construction industry. *Epidemiologic reviews*, 34(1), 156-167.

Siu, O. L., Phillips, D. R., & Leung, T. W. (2004). Safety climate andsafety performance among construction workers in Hong Kong: The role of psychological strains as mediators. Accident Analysis & Prevention, 36, 359–366.

Verdenberg, A.G. (2002). Organizational safety. Which management practices are most effective in reducing employee injury rates? *Journal of Safety Research*, 33, 259-276.